

# NASA TECH BRIEF

## *Lewis Research Center*



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### Design Criteria Monograph for Valve Assemblies

A design criteria monograph has been published which is a summary and a systematic ordering of the large and loosely organized body of existing successful design techniques and practices for the design of liquid rocket valve assemblies.

This monograph was written to organize and present, for effective use in design, the significant experience and knowledge accumulated by NASA in development and operational programs. It reviews and assesses current design practices, and from them establishes firm guidance for achieving greater consistency in design, increased reliability in the end product, and greater efficiency in the design effort. The monograph is limited to valve selection factors for trade-off studies, configuration analyses, actuator selection, and integration of components.

The material in this monograph is organized along lines of the valve design sequence. A new valve design for a rocket engine propellant, pressurization, or hydraulic/pneumatic control system starts with a configuration analysis utilizing accurate design requirements that result from the analysis of the engine control system. A preliminary layout with supporting calculations results from the configuration analysis. The next step is a detailed functional analysis by which the various components of the valve are sized. The components then are integrated into the valve assembly. Final design reviews are made, and drawings are released. The designer's tasks conclude with fabrication followup, prototype assembly, valve development, and qualification of the design.

The valving for liquid rocket engine propellant and pressurant systems encompasses a variety of valving unit and actuator combinations. Valve functions include shutoff, routing of flow, and throttling. Service fluids include cryogenic, earth-storable, and space-storable propellants; hydraulic fluids; pressurizing gases; and hot-gas combustion products.

The most widely used basic valving-unit types are poppet, butterfly, and ball. The poppet has proved to be a reliable and versatile unit that has found wide use in rocket engine fluid control. The butterfly valve design has been improved to achieve tight shutoff and reduced seal wear by off-center eccentric disk motion; the butterfly

valve is used primarily in one-start booster propulsion systems. In the ball valve, which has been used extensively in rocket engine systems, progress has been made in achieving adequate seal life with the simple nonretractable seal. A retractable-seal ball valve or a fixed seat and translating ball element offers the sealing features and high cycle life of the poppet with the flow characteristics of the ball.

The monograph comprises two major sections: State of the Art, and Design Criteria and Recommended Practices. References complement the text.

The State of the Art section reviews and discusses the total design problem and identifies the design elements that are involved in successful design. The Design Criteria state clearly and briefly each rule, guide, limitation, or standard that must be imposed on each essential design element to assure successful design; the Recommended Practices set forth the best available procedures for satisfying the Design Criteria.

Both major sections are divided into five subject categories: Valve Selection (characteristics, materials, contamination, tolerance); Major Design Parameters (shapes, types, failure modes, forces, response); Design Integration of Valve Subassemblies (transmission, loads, integration, environmental factors, filtering, instrumentation); Assembly of Components and Functional Test; and Engine, Stage, and Spacecraft Checkout.

This thorough review of design criteria and practices relating to valve assemblies should be useful for a wide range of valving applications and should be of interest to designers and manufacturers of valves and to designers and manufacturers of associated equipment.

#### Notes:

1. This monograph has been published as the following report:

NASA SP-8097 (N74-26979), Liquid Rocket Valve Assemblies

(continued overleaf)

Copies may be obtained at cost from:

Aerospace Research Applications Center  
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2. Specific technical questions may be directed to:

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